PUBLIC DOCUMENT. No. 4.

FOURTH ANNUAL REPORT

OF THE

NORTH DAKOTA

AGRICULTURAL EXPERIMENT STATION

FARGO, N. D.

TO THE GOVERNOR.

February 1st, 1894.

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HERALD, STATE PRINTERS AND BINDERS.
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His Excellency,

HON. E. C. D. SHORTRIDGE,

Governor of North Dakota.

SIR: Complying with the Act of Congress, approved March 2nd, 1887, and in accordance with custom, I hereby submit the Fourth Annual Report of the North Dakota Agricultural Experiment Station for the year ending February 1st, 1894, together with a financial statement of receipts and disbursements, as required by law, for the Government fiscal year ending June 30th, 1893.

I remain, sir, most respectfully yours,

J. B. POWER,

Director.

Fargo, N. D., Feb. 1st, 1894.

BOARD OF CONTROL.

H. F. Miller, President,.....Fargo.
J. B. Power, Secretary,.....Power.
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STATION STAFF.

J. B. Power,.....Director.
E. F. Ladd, B. S.,.....Chemist.
T. D. Hinebauch, M. S., V. S.,.....Veterinarian.
C. B. Waldron, B. S.,.....Horticulturist.
H. L. Bolley, M. S.,.....Botanist.
J. H. Shepperd, M. S. A.,.....Agriculturist.
W. G. Hiatt,.....Farm Superintendent.
Wm. G. Hayden,.....Secretary.

REPORT.

To the Board of Control:

As stated in the last annual report, the work of the Station during the year then closing, was devoted largely to the preliminary arrangements necessary to organization, preparation, division of grounds required for the inauguration of systematic experiments, and the general cultivation of the entire station farm. The work thus inaugurated has been carried forward the present year, as closely as possible, in accord with the plans and on the lines then comtemplated.

The principal object in view in all the experiment work of the Station is to obtain results that will be of practical value to the farmers of our state, and the various lines of investigation for this purpose are under the immediate charge of the heads of the different departments. A resume of the work is furnished by short reports from each department, and is as follows:

CHEMICAL DEPARTMENT.

In the chemical department the work has been a continuation of the investigation of the soils of North Dakota. About thirty soils have been collected from various localities and the analyses are in part completed.

Analyses of water from wells, springs, and artesian wells have taken considerable time. Analyses of waters have been made for sanitary purposes. In one case, at least, the probable cause of colic among farm horses was traced to the drinking of bad water, that is, water containing large quantities of sodium, and magnesium sulphate. This was a fact of much importance to the parties interested.

Several analyses have been made for supposed poisons in feeding products, and in one case it is fairly certain that the trouble came from injudicious feeding of concentrated food. In another case under investigation, a family of five were supposed to have been poisoned by eating honey. It was pretty clearly demonstrated that the poison came from ptomaines resulting from decomposition in honey. In various ways the people of the State have called upon the department for aid and advice.

The work in meteorology has been continued by this department, and monthly reports have been made to the State Weather Bureau, and to the Department of Agriculture at Washington.

From April to November a determination of the per cent of water contained in the soil from a cultivated field on the college farm has been made; in the surface soil from one to three inches in depth and in the sub soil from five to seven inches. The average for each month, together with the results for 1892, are given in the following table:

	SURFACE SOIL. 1 to 3 inches.		SUBSOIL. 5 to 7 inches.	
	1893	1892	1893	1892
April		53.92		46.86
May	31.48	35.08	30.21	35.51
June	29.63	29.08	23.79	30.22
July	28.63	28.39	26.97	27.19
August	21.46	30.03	21.57	30.53
September	18.88	28.29	19.71	27.94
October	24.59	16.53	24.02	22.29

The above table shows the soil to have contained considerable more moisture when the ground froze the past fall than in 1892, and gives indications that may prove to be of value in agriculture when the data have been collected for a sufficiently long period to enable one to draw conclusions.

The following table gives the maxima, minima, and mean temperatures and rainfall for each month of 1892 and 1893.

	MAXIMA.		MINIMA.		MEAN.		RAINFALL	
	1893	1892	1893	1892	1893	1892	1893	1892
January	38	42	--32	--35	-3.0	2.7	.22	.04
February	42	43	--41	--28	-1.4	10.1	.11	.27
March	39	65	--27	--17	10.9	21.0	.71	1.07
April	56	65	10	lost	32.6	38.1	2.63	2.42
May	84	70	26	27	51.8	46.0	0.77	3.88
June	101	83	41	37	70.1	62.8	3.62	1.93
July	93	87	44	40	70.4	68.9	2.20	5.02
August	94	88	34	39	65.4	67.4	2.72	4.03
September	90	84	15	31	56.7	59.7	.87	1.39
October	72	83	11	12	36.3	47.0	.90	.36
November	36.2	52	8.9	--12		20.0	1.	.50
December	12.2	38	--10.9	--27		5.4	.41	.12

VETERINARY DEPARTMENT.

The work of the veterinary department this year has been a continuation of that of last year. The influence on horses of the feeding of millet has been more thoroughly studied. At the present time we have ascertained the action of millet about one-third headed when used exclusively as an article of food.

We shall conduct further experiments to determine the action of millet which is unheaded, and also the action of the seed, or millet which is pretty thoroughly ripened.

Considerable time has been devoted to answering inquiries

which have come in very freely from the stock owners of the State.

Next year, in addition to the continuation of the present experiment, we shall also conduct an experiment relative to the ventilation of barns in the State, and the effects of poor ventilation on the stock which they contain, making careful and accurate data with regard to the same.

HORTICULTURAL DEPARTMENT.

The work in the horticultural department has been conducted along existing lines in the matter of testing the hardiness of new and hitherto untried sorts of trees and friuts, while in addition to this, several cultural experiments with different sorts of vegetables have been begun.

In addition to the report of last year on fruit and forest trees, it may be said that the arbor vitæ, or white cedar, endured the severe cold of the past winter much better than did the Norway Spruce.

Our present experience with young trees in this locality, shows that the most trying time for the arbor vitæ is during a season of dry hot winds from the south, while the spruces are most injured by cold north winds.

The rust of the cottonwood mentioned in the last report was absent last season, but this tree everywhere suffered from an attack quite as serious in the leaf borer, a larva which works beneath the epidermis of the leaf, often to the extent of defoliating the tree, and in all cases rendering it unsightly because of the blackened leaves. The "bladder" disease (*Taphrini pruni*) of the wild plum, so common in the season of 1892 as to destroy the entire crop in many sections, did not put in an appearance in 1893. The same trees in the Station nursuries that were badly attacked the former season, bore large crops of perfectly healthy fruit last season.

When the life history of the disease is taken into account, the question naturally arises as to whether it is not checked by certain climatic conditions, particularly excessive cold. It will be interesting to note in the future the appearance or non-appearance of this malady after winters of unusual severity, and also whether trees in sheltered localities are more liable to attack than those in exposed places.

In the vegetable garden the cultural experiments with tomatoes, to test the effect of different methods of training upon the time of ripening, gave no difference in results.

At other places it has generally been found that tomatoes trained to one or two vines, ripened their fruit earlier than the untrained vines. Whether this early ripening is due to a changed physiological condition of the plant from the effect of pruning, or

whether the fruit ripens earlier because of the more direct exposure to air and sunlight, has not been determined.

The fact that, in this locality, where the summer days are very long and sunny, and the warm air moves freely and constantly, untrained plants ripen their fruit as soon as the others, would incline one to the latter supposition.

If any given branch upon which fruit is borne is freely exposed to air and light, there is no reason to suppose that any special form of training can hasten the maturity.

The growing of tomatoes from seed produced by three year old plants that have been starved during that period will be a feature of the coming season's work, in order to determine if precocity or enforced earliness of maturity can be transmitted by seed to the next generation. The principle here involved is at present very prominent in general biology, and in all its applications to the breeding of plants and animals.

In previous years it has been found impossible properly to mature the larger and better sorts of onions in this locality, owing to the shortness of the season, and also probably to the character of the soil. Last season twenty-six sorts of onions were selected with a view of determining the effect of transplanting upon size and earliness. Half of the seed of each sort was sown under glass from April 5th to April 10th, the remainder being sown in open ground from May 20th to May 24th. At the same time the plants grown under glass were transplanted, under the exact conditions of those sown in open soil.

The results show a remarkable increase in size and earliness of maturity of the transplanted onions over the others. This was true not only of larger and later sorts like the Rocca, Prizetaker and Pompeii, but also of the kinds that are smaller and earlier, as the Early Red, that are supposed to mature anywhere in the United States.

The comparative yields from the two methods of culture were estimated from the following varieties, the others being excluded on account of greater or less failure of seed germination. Yellow Globe Danvers, Silver Ball, Pompeii, Red Globe, Red Victoria, Giant White Italian, White Globe, White Victoria and Silver White Ætna.

The average ratio of yield with these sorts was forty-nine pounds, (yield) of the transplanted, to eleven and a half pounds of the non-transplanted.

The average ratio of weight between single bulbs was practically the same as that of the total yield.

The transplanted bulbs in all cases reached maturity, while only the Early Red, Red Globe, Danvers, Ætna and Barletta matured from the seed sown in open soil.

The experiment was made on unmanured black prairie soil.

The different methods in culture produced no difference in quality.

The transplanted bulbs were from one-eight to one-fourth of an inch in thickness at the time of transplanting, while all the large sorts yielded bulbs from twelve to sixteen inches in circumference at the time of harvesting.

The experiment will be continued the coming season with conditions varied as to soil and age of plants transplanted.

BOTANICAL DEPARTMENT.

The head of this department, because of the union of the college and the experiment station work, directs also the work of the college department of botany and zoology. The instruction work during the year has been from two to four hours per day, and together with the necessary collection and preparation of materials for class room work may be fairly stated as occupying something more than half the available time. A portion of this college work, such as the collection, preservation, and examination of plant specimens, becomes available for and advantageous to the experimental work. It may thus be reported with a fair degree of accuracy that one-half of the time of the department is given to Experiment Station work.

The work of the year has naturally been prosecuted along the general lines heretofore laid down and reported upon in previous reports. It has been chiefly studies in plant physiology and pathology, aiming at accuracy of conclusions in those lines, rather than at immediate economic ends, though the latter constitute a desideratum always in mind.

Economic results in those lines of investigation are necessarily of slow development, coming only after persistent and long continued search for facts which, together with compilations of the work of others, must constitute the basis for experimental operations. Thus while no inconsiderable part of the time of the department has been given to the study of certain plant diseases and physiological questions related thereto, occular and demonstrated evidence of results is not so marked as might be wished. It is hoped, however, that such results as have been published, together with the associated recommendations, may prove valuable aids to farmers of the State. This of necessity cannot be realized unless the ones for whom the bulletins are written, carefully note the most essential points recommended, and to a certain extent investigate the same for themselves. It is pleasing to note that this personal interest in investigation is very general among the farmers of the State. Thus, for example, concerning the disease known as "stinking smut" in wheat much interest has been evidenced by farmers in all parts of the State in obtaining facts concerning its method of propagation, and the best means

of avoiding its occurrence. Since the preparation of Bulletin No. 1, more than one hundred letters of inquiry have been received and answered upon this subject alone. It is believed that the origin of this disease in the crop, and the best means of avoiding it are now quite generally understood by the principal farmers of the state, though only a few years since it was quite generally believed that this disease and many similar ones were due to causes unavoidable—as, for example, atmospheric conditions.

In view of the fact that stinking smut (*Tilletia fœtens, B. and C.*) was more widely spread and more generally destructive throughout the State during the past year than heretofore, it may not be inappropriate again to call attention to the fact that to avoid the reoccurrence of the smut it is necessary that the farmer should select his seed wheat from an uncontaminated lot. Seed wheats ought not to be selected from elevators in which miscellaneous lots of wheat have been stored; one smutted load intermixed here contaminates the whole. All who use such seed must reap a smutted crop. Acting upon this information the Railroad Commissioners of the state propose an arrangement whereby those wishing to purchase uncontaminated wheat for seed purposes may have the same transported at half the regular freight rates. Even if this cannot be accomplished, no farmer can afford to introduce the disease upon his farm simply because of the slight cost attendent upon the purchase of a pure strain of clean seed.

This matter of the introduction of pests in the line of plant diseases is one of extreme importance. In this new country the soil and the farm are free from many which infest older cultivated districts. To keep the State free from such is money in the pocket of every farmer. When once present these diseases must be dealt with by heroic methods. This costs a certain outlay of cash in addition to the damages arising from a decrease in yield or value because of the presence of the diseases.

As examples of such destructive diseases of plants which are common in older cultivated regions I need here call attention to only a few which may attack three of our most staple crops. The "stinking smut" (*Tilletia fœtens, B. and C.*) is not in any sense a native of this region. New and uninfested farm lands are being opened up and developed throughout the State, and a little vigilance rightly applied will suffice to keep the grain product and granaries of such free from the smut for an indefinite time. The potato plant, in many districts where its cultivation has been continuous; is attacked by a number of plant parasites, the action of which, separately or combined, often results in the complete destruction of the crop, as witness, the Irish potato famines. These potato diseases when once introduced into the soil remain practically ineradicable, the amount of damage done each year depending chiefly upon climatic conditions. Three of

these may be mentioned; early potato blight (*Macrosporium solani E. and M.*) potato rot (*Phytophthora infestens D. By*) and potato scab (*Oospora scabies Thax.*) Only the last named of these pernicious diseases is as yet present in this State, and that only in old potato plots of comparatively small area, which may be abandoned to other crops, and potatoes grown on new land. Great care, however, should be exercised to avoid introducing diseased tubers on this new land. Bulletins Nos. 4 and 9 of this station point out an easy method of preventing this disease.

Flax is attacked by an unknown disease, in Minnesota, which has not as yet been noted as occurring in North Dakota. This disease is said at times to cause a total loss of the crop.

It is particularly wished that persons noting any generally unhealthy conditions of cultivated plants or crops would feel interested in reporting the same to this department. Any obtainable facts bearing upon such questions as may be asked will be gladly given. In this manner advantageous knowledge is gained both by the questioner and the Institution.

PUBLICATIONS.

Two publications have been issued from this department since the last report.

In Bulletin No. 9 work is reported under two heads "Conditions affecting the value of wheat for seed" and the "Prevention of Potato Scab." The first article is a resume of studies and tests upon a number of types of injured seed wheats as "frosted before maturity" "bin burned," "winter bleached in shock" etc. The results of the work upon which this article was based, show among other points, that immature wheats, no matter what the cause, are weakened in seed value, and that it is not safe to use any wheat for seed purposes that has been subjected to either heating or freezing when in a damp condition, no matter how plump and fair the sample may appear externally. It is also found, contrary to the generally accepted view, that wheat frosted before maturity, cannot be relied upon for a good crop, because of the weak growth immediately following germination.

This work upon wheat has been continued in field experiments, and will be reported in a bulletin now in preparation.

The article relating to potato scab was a report of the continuation and completion of the work upon that subject, from the standpoint of treatment of the seed for prevention. The corrosive treatment previously recommended in Bulletin No. 4 was again found to be entirely successful even to a marked increase in yield. It may be noted here that many farmers have reported a like success when the solution was applied to the seed tubers for entire crops. Thus Mr. E. H. Currier of River Falls, Wisconsin, writes to Rural New Yorker, October 21st, 1893, that his cost was fifteen to twenty cents per acre for treatment. Other conditions being

equal, the increase in value of the crop from treated seed over that from untreated seed was an average of $8 per acre on a crop of forty acres. Mr. Currier planted 140 bushels of untreated seed and 560 bushels of the treated seed. From this evidence it can be affirmed with confidence that the method is practical on a large scale, and that it is a slight precautionary means which must inevitably result in increased value of the crop, both in increase of yield and quality of the product.

Press Bulletin No. 1 is a short article upon the weed known as Russian cactus (*Salsola Kali, var, Tragus D. C.*) The object of the article was to impress upon the people of the State the necessity of immediate concerted effort to prevent the further encroachment of the plant upon cultivated and waste lands. Investigations made along the Fargo Southwestern Railway found that the weed is rapidly extending its range and capability to do damage. The people are becoming thoroughly alive to the necessity of definite action upon this the worst weed at present known, and through the senate have asked the United States for aid. If such aid is given it can be of great advantage to the farmers of this State in combating the advance of the weed. It may be well to note here, however, that no matter how much aid comes from the general government, the effort to rid the State of the plant will be without lasting value unless every farmer applies himself assiduously to its destruction upon and about his own lands.

WORK ON NATIVE FLORA.

The collection, classification, and study of the native plants of the State have been continued.

WEEDS: Because of the extensive farm operations in this state, which do not admit of the use of the hoe and allied implements, weeds are becoming a source of much economic concern. It is important that the seeds of such plants should be widely known, and thus readily recognized when intermixed with seed grain. During this past summer seeds of about fifty species of such plants have been collected in quantity for reference and study. When this collection is completed it will form a source of much value for reference both to the Station and College.

GRASSES: The survey, as well as the collection of the native grasses, though not finished, is comparatively complete and a catalogue and bulletin upon that subject is in preparation. It is the purpose that each variety shall be written up, noting its forage qualities, distribution, means of propagation, and other characteristics of general interest.

In this connection I call attention to what I believe to be a most grievous error which is gradually being committed by the people of the State. It is the continued breaking up of the wild or native prairie sod without other apparent reason than that of getting it turned under. Many, especially those occupying farms

in those portions of the State where there is a lack of moisture and the soil is light, will be sorry for this after the turf is gone never to return. Full reasons need not be given at this time, but there are many which are pertinent to every observer. Much of this sod is broken only to lie idle for the accumulation and propagation of pestiferous weeds. The better types of native grasses when once plowed under, never re-occupy the ground, and, in most parts, the development of pasture lands from the seed of tame types will be found to be a costly and tiresome task.

WORK AND EXHIBITS AT THE COLUMBIAN EXPOSITION.

The regular work of the year has been considerably broken into by the time given to the preparation of exhibit materials for the Station and the College at the Fair; also as detail for the month of July from the Station as botanical demonstrator in the United States Model Experiment Station.

Besides a certain amount of aid given to the State Commission in the preparation and preservations of specimens, this department made the following exhibits:

1. In the Model Experiment Station. (1.) Card and thirty alcoholic specimens showing the distribution of the parasitic plants called root tubercule formers, or nitrogen gatherers upon native leguminous plants of the State. (2.) Four large jars of pickled potatoes and beets illustrating the effect of the use of corrosive sublimate to prevent the occurrence of potato scab. (3.) Specimens of fifteeen of the worst weeds of the state, furnished to and exhibited by Prof. B. D. Halsted. (4.) Thirty specimens with pen drawings illustrating the plant diseases, known as rusts (*Uredinæ*) as found upon the common cereals of the United States.

2. A complete exhibit of the native and cultivated grasses of the State exhibited in the Agricultural Building. There were eighty native species represented in the collection, besides representatives of all cultivated and introduced types which have been found in the State to date, together with representatives of the different sedges found. In all there were three hundred ninety-eight different bunches which occupied a total wall space eight by seventy feet. This was generally conceded to be the most extensive, best and most complete exhibit of grasses made by any state, and as such received a medal.

This collection of grasses has be enreturned to the Station, and as the department is possessed of duplicate bunches, exchanges will gladly be made with botanists having similar collections from other states.

AGRICULTURAL DEPARTMENT.

The work of the agricultural department, during the year 1893 was, necessarily, confined to experiments with crops and farm management, to erecting the necessary buildings and fences, and to the purchase of stock, etc. W. M. Hays resigned October 1st and J. H. Shepperd, who was elected to the position of agriculturist, took charge November 1st.

The station farm has been further improved by more drainage, a large drain, partly made in 1892 by the Station, having been nearly completed in 1893 by the drainage commission of Cass County. This drain will reclaim fifty acres of lake bottom land, most valuable for certain experiments, provides an outlet for the excellent drainage system of the farm, which is nearly perfected, and makes needed sewerage from the station buildings possible, besides preventing an overflow upon the farm during excessively wet springs, as were the last two. About thirty acres have been fenced for pasture. A tract of thirty acres of native sod, which it was hoped could be saved as a piece of virgin soil, proved to be so filled with wild bárley (*Hordeum jubatum*) and various introduced weeds that it was worthless for meadow land, and consequently was plowed up. The native sod had been so much modified by having been used for a pasture during a number of years by a neighbor, while the land was a "school section" that it was worthless to save with a view to doing experiments on native pasture and meadow sods.

FARM ACCOUNTS.

A scheme of farm accounts has been instituted which gives the cost of each field (treated as an enterprise) and of each operation in the course of crop production, as plowing, seeding, etc.; gives the cost of each class of stock, boarding the help, of the several lines of experiment work, and of the general service this department gives the college in the way of team work, etc.

BULLETINS.

Two Bulletins Nos. 10 and 11 were issued during the year. Some of the results of experiments shown in the Bulletin No. 10 were briefly stated in the last annual report. In Bulletin No. 11 various practical results of tests are shown: 1. Wheat seeded late yielded twelve bushels, and that seeded early fifteen bushels per acre. 2. Fife wheat on ten plots averaged 10.6 bushels per acre, while Hayne's Blue Stem on ten adjacent plots yielded 16.9 bushels per acre. 3. Four plots two of which were fife and two Hayne's Blue Stem, at the several rates of seed per acre yielded on old ground, respectively as follows.

Three Pecks Seed Yielded	11.9 Bushels Wheat
Four Pecks Seed Yielded	13.3 Bushels Wheat
Four and One-half Pecks Seed Yielded	14.6 Bushels Wheat
Five Pecks Seed Yielded	14.1 Bushels Wheat
Six Pecks Seed Yielded	14.8 Bushels Wheat

4. Five to seven inches apart for shoes on wheat drills was best. 5. Deeper spring plowing of stubble land was found to destroy more rose bushes and other weeds than shallow plowing. 6. In comparing surface cultivation and stubble seeding of wheat with regular methods, it has now been shown by three trials in the State that only in exceptional cases does thick seeding pay. 7. Broadcasting is not as good as seeding only in exceptional cases. 8. Hoe drills are not nearly so satisfactory as shoe drills. 9. Except in very loose soils and in very droughty spring time conditions, shoe chain drills do as well as shoe press drills, and less power is required to draw them. A successful machine is needed which can be used with or without wheels. 10. Some of the new varieties of hard wheats, under trial for two years here, and previously one year in Minnesota (at Glyndon, ten miles east of Fargo) seem better than either Fife or Blue Stem. 11. Oats sown broadcast, and that seeded rather late with the hoe drill, are not nearly as successful as those seeded with shoe-chain, and shoe-press drills. 12. Seeding oats in the stubble was a failure. 13. Nine to ten pecks per acre of seed barley produced the largest yield. 14. In the rotation experiments rye, oats and barley alternating with wheat did not help future wheat crops. 15. Bare fallowing on land cropped ten years to wheat increased the yield-sixty five per cent. for the next year. 16. Cultivated crops instead of a bare fallow increased the crop 85 per cent. 17. Field peas instead of the bare fallow increased the next crop of wheat 34 per cent. 18. Millet instead of the bare fallow increased the following crop of wheat 50 per cent. 19. All farmers especially those not on clay soils should get a few bushels of field peas, learn how to grow them, save seed, and make of this a diversifying crop to help feed hogs and other stock, and to help "keep up" the land. 20. Nothing better than Timothy, Red Top, and Red Clover have been found for hay and pasturage in rotation with grain crops.

Bromus inermis is a promising new grain.

STATION STAFF.

Changes have been made in the station staff during the past year as follows:

H. E. Stockbridge, Director, removed by order of the Board of Trustees on the 9th day of May, and the vacancy immediately filled by the appointment of J. B. Power, Secretary and member of the Executive Committee of Board of Trustees. Mr. Power still retains his position on the Board.

L. B. Hibbard, Farm Superintendent, term expired April 1st, was succeeded by W. G. Hiatt.

W. M. Hays, Agriculturist, resigned October 1st, to accept an appointment at the Minnesota Station and succeeded by John H. Shepperd, M. S. A., graduate of the Iowa Agricultural College,

post graduate Wisconsin University in dairying, and lately, assistant editor of the Orange Judd Farmer.

H. W. McArdle, assistant in horticulture and W. H. Whalen, assistant chemist were transferred to the College faculty on the first of January.

The farm house is a commodious dwelling, with ample room for the accommodation of the Farm Superintendent, his assistants, and all the farm help. During the present winter term, part of the building will be used for experimental and practical instruction in dairying.

The barn is large and complete, the main part 150x40 with 24 foot posts, and a wing 80x36, with 20 foot posts. It contains stalls for twenty-eight head of horses and thirty-five head of cattle; also several box stalls, large silo, large room on ground floor furnished with stock and wagon scales, feed grinder and cutter, grain and hay elevating machinery; seed, tool and work shop rooms, grain bins on both floors, and large hay bays. It contains also an office and commodious lecture room.

The arrangement of the barn permits careful work in feeding experiments with all animals in hand, particularly so with horses, both during their idle and working seasons.

PUBLICATIONS.

During the year the following bulletins have been issued:

Bulletin No. 9 treats of conditions affecting the value of wheat for seed, and of the prevention of potato scab.

The climatic conditions of 1891 provided a great variety of poor seed wheat. Samples were selected from (1) immature wheat, (2) wheat injured in shock, in stack or in bin, (3) wheat designated as "frosted wheat," or injured from various causes, and tests were made to determine whether a sufficient amount would germinate to warrant farmers in using such wheat for seed.

The principal conclusions reached were that immature wheats, from whatever cause, are weakened in seed value; mixed varieties should not be sown because of inequality in ripening.

The best grades of frosted wheat possess less strength in their first growth than the best grades of mature wheat.

Wheat that has been wet and subjected to freezing and thawing during the winter cannot be safely used for seed.

Wheat that has been heated when in bulk is injured for seed. Wheat in shock all winter is usually worthless as seed.

The dryest, heaviest, hardest, best market grades are the ones to rely upon for good seed.

PREVENTION OF POTATO SCAB.

The portion or Bulletin No. 9 devoted to this subject is practically a supplement to bulletin No. 4, embracing the recommendations made in that bulletin, and showing that the disease can be prevented, the method of treatment, and the improvement of crop by eradication of the disease.

Bulletin No. 10 treats of

(*a.*) Grain and forage crops, showing experiments on one hundred forty varieties of wheat with a view to the improvement of these varieties, by crossing and selection.

(*b.*) Experiments as to amount of seed wheat and oats per acre.

(*c.*) Tests of varieties of millet and flax.

(*d.*) Experiments in corn for fodder and for ear, embracing twenty-eight varieties, grown at three different localties, the value of corn in the rotation of crops.

(*e.*) Tests of twenty-four varieties of field peas for crop and for benefit as a green crop for fertilizing worn out lands.

(*f.*) Results of rotation crops.

(*g.*) Experiments in fall plowing vs. spring plowing vs. disking.

(*h.*) Seeding by press drills, hoe drills and broadcasting, seeding on wheat stubble and on corn stubble.

Bulletin No. 11 also treats of grain and forage crops, and is a report of experiments commenced in 1892; some on an enlarged scale, for the purpose of a closer determination of results, than was obtained the first year.

A brief statement of some of the conclusions reached by these experiments may be of interest.

1. Of one hundred thirty kinds of spring wheat no other hard varieties prove better than the two recognized standards, Fife and Blue Stem. (See page 16, bulletin No. 11.)

2. Broom corn millet not a real millet (*Letaria*) but a Panicum (*Panicum Melliaceum*) is nearly like millet in yield, produces two tons of hay per acre at a fair average, and promises to be of great value both for hay and grain.

3. Flax, for seed, is a good crop; moist or strong lands produce the best fibre; sow seed known to be free from mustard.

4. Large varieties of sweet corn and medium dent kinds are better for fodder. Smaller flints are more certain to ripen and yield more grain per acre. While only fair yields of corn can be expected in North Dakota, the yield in fodder will always be sufficient to pay for the cultivation of the crop. The proper cultivation of this crop leaves the ground in better condition for wheat, than does barren fallowing.

5. Field pease is a very promising crop, especially on light sandy lands where the soil is deficient in its supply of nitrogen for wheat. This leguminous crop is of great value. It yields as well, under ordinary conditions, as wheat, commands a higher price, besides furnishing valuable sheep food in the straw.

6. The average yield of wheat in 1893 from six plats on which wheat had grown continously for ten years, was 9.4 bushels. On three plats of same,—except growth of oats, barley and spring rye 1892,—the average yield was 9.0 bushels.

On four plats of same, barren followed in 1892 the yield was 15.4 bushels.

On four plats, planted in 1892 to hoed crops corn, rape and mangles the yield was 17.4 bushels.

The average from three plats, to peas in 1892, was 12.6 bushels.

The average for three plats, in Millet in 1892, was 14.1 bushels.

Present results seem to justify the expense and effort of continuing in this line of experiments to determine the adaptability of rotation in keeping land clean of weeds, fertile in plant food, in good mechanical and physical condition and which rotations bring the largest net profits.

BULLETIN ON THE RUSSIAN CACTUS.

This obnoxious and troublesome weed has now become so formidable in its encroachments and such a menace to the farming interests of the State that it was deemed well to make a general study of its characteristics, in the hope of being able to suggest some methods of eradication in the counties now infested, and at the same time to be able to suggest how its further distribution could be prevented. The botanist of the Station finds that at present it occupies to the exclusion of other plants, about one-third of the cultivated lands of three counties, and is quite generally distributed in several others of the southern counties of the State, while a considerable portion of South Dakota is also occupied. The area infested by the weed in the two states is estimated at about 30,000 square miles. Prof. Bolley describes the weed as follows:

"The weed is not a cactus or a thistle, but is commonly named Russian Cactus and Russian Thistle because of its origin, and thorny nature. It is a near relative of the native tumble weed (*Amarantus albus*, L.) and like it scatters its seed principally by tumbling before the wind. Its size varies, accordingly as it is or is not crowded in its growth, from slight stiff sprigs, three to six inches high to a dense, much branched, harsh, thorny, rounded bunch, three to six feet in diameter. It is delicate and succulent while young, but as it nears maturity the branches become hard and stiff and bear many small rose colored flowers. The latter are arranged alternately, about one-fourth of an inch apart, and are enclosed by three short stiff, thorn-like leaflets. Before blackened by frost the stems are striped with red. Besides dropping out as the weed tumbles along, the individual seeds may be blown short distances because of the slight wings formed by the dried blossom parts in which each is enclosed."

The edition of this bulletin being exhausted, I quote in full his remarks and suggestions. Under the heading, "Points to Keep in Mind" he says:

"This weed grows only from the seed. Only weeds which have been allowed to reach large size ever tumble. These are, in most parts, found only in waste places, or improperly cultivated spots, such margins of wheat fields, old fire breaks, gopher knolls, etc. A good fence will stop most of these.

"At any time when weeds are mature enough to break loose of their own accord they can be collected and burned.

"When young, the plant is eaten greedily by sheep and cattle.

"The weed perishes immediately by being uprooted or cut off at the base; and its seed are short lived. When growing in small form because of its density upon the ground, it may be turned under by the plow in early August, and thus in most parts destroyed; or if left until mature there will be a time late in the fall when it together with the stubble and other weeds may be cleared from the land by fire.

"It does not grow upon the native prairie sod, save where there are bare spots. During the month of August a comparatively small force of workmen would suffice to destroy all weeds upon road margins and the wild lands of the worst infested township in the state.

"The weed matures its seed but slowly, so that if destroyed during the early portion of the season, frost will very effectually destroy the later plants.

"Aside from its tumbling capacities this weed possesses no quality which would make it hard to exterminate under a careful system of farming and road management.

"To summarize, this weed is spreading more rapidly, perhaps, than any heretofore known, and under the present loose attention which it is receiving, will soon cause an enormous amount of damage thoughout the State. When once it has generally taken possession of a large area of land, only heroic measures will keep it in check. There are however, no good reasons why it should be allowed continually to encroach upon new land."

SUGGESTIONS.

"Sow no small grain that is not thoroughly clean from weed seeds. The seed of this plant is as large as a mustard seed, and may be known by the fact that the embryo is spirally coiled, in form like a small snail shell.

"A good wire fence is of much advantage.

"Do not break up any more of the native sod than you can tend and keep clean.

"Put all land sown to wheat or small grain in such condition that the crop may have the best possible start of the weed.

"Do not allow scattering weeds to reach tumbling size. Where it is abundant, now, rake and stack as you would hay until the time comes when you can burn it.

"The weed should be plowed under when immature.

"Never try to run a barren fallow where this plant is abundant.

"Patches of the weed may be effectually destroyed as follows: Instead of trying to run a barren fallow sow on a fair quantity of the small grains, say rye, wheat, or oats, pasture until late in July or first of August then turn under thoroughly.

"To keep land which is as yet free from the pest from becoming seeded by the tumbling weeds and free seeds, the following plan is worthy of trial; sow each spring a strip of sun flowers about one drill width around each field. Induce these to grow as dense and strong as possible. Leave the stalk standing during the following autumn and winter, clearing the ground by fire in the spring.

"We believe that each farmer can readily keep his own farm clear of this weed, provided it is kept off the waste lands and roadside."

The rapidity with which this pest is taking possession of the ground, the large areas already occupied, and the inability of the farmers, in the infested districts, to cope with it, show the necessity of energetic and radical measures to destroy it. Senator Hansbrough, active to the interests of agriculture, and appreciating the need of national and local co-operative effort has introduced a bill in congress appropriating $1,000,000 toward defraying the expense of eradicating the weed. Without the congressional aid to supplement the local work of townships and counties, we fear almost complete abandonment of lands in some of the infested localities.

The annual report gives a mere summary of the results of the past year's work. The regularly issued bulletins give detailed statements of methods and results of investigations in special lines. These bulletins are mailed regularly to all citizens of the State requesting the same. In closing I quote from last year's report and wish to emphasize the statement that "The North Dakota Agricultural Experiment Station is distinctively a farmers' institution, conducted in the interest of the farmer." We wish the farmers of the State to recognize the possibility of assistance in their work by the Station, to familiarize themselves with its work, to aid by expression of personal interest, assistance and suggestion, and to this end we further ask that, by correspondence or otherwise, they place themselves in touch with the Station and its working staff.

J. B. POWER,
Director.

January 20th, 1894.

The Agricultural Experiment Station of North Dakota in Account with the United States for the Year Ending June 30th, 1893.

1892.	RECEIPT DR.	
July 1.	Balance of Special Appropriation on hand	$ 563 62
July 29.	Received from U. S. Treasurer	3,750 00
Oct. 14.	Received from U. S. Treasurer	3,750 00
1893.		
Jan. 9.	Received from U. S. Treasurer	3,750 00
June 30.	Received from U. S. Treasurer	3,750 00
	Total Receipt	$15,563 62

1893.	EXPENDITURES CR.	
June 30.	Apparatus	$ 254 61
	Books	173 43
	Freight and Express	237 00
	Fuel	1,653 72
	Labor	4,765 74
	Postage	145 37
	Printing	668 35
	Rent	733 00
	Repairs	72 60
	Salaries	3,762 14
	Stationary	117 64
	Supplies	2,078 92
	Telegraph and Telephone	138 44
	Traveling Expenses	74 60
	Building	688 06
	Total Expenses	$15,563 62

The above is a correct statement of receipts and expenditures of government appropriations for the North Dakota Agricultural Experiment Station for the year ending June 30th, 1893, as taken from my books.

Wm. G. Hayden,
Accounting Officer for the Board of Control.